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Extraction of Coconut Oil by Small-Scale Processors in Ghana: Operations and Constraints

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Abstract
This article explores the various procedures and constraints associated with coconut oil processing by small-scale processors in Jomoro District of the Western Region of Ghana. Thirty (30) respondents from four randomly selected villages with significant coconut oil production and processing were interviewed using a questionnaire. The study revealed 53% males and 47% females, 87% within the age of 20-49 years with 53.3% literate are engaged in the enterprise. Processing of coconut oil involves removing husk using a spike, cracking shell with a cutlass to remove the meat followed by size reduction into fine textured fibre by a rotary grater. Fibre is mixed with water to obtain milk, which is decanted into long plastic/metal barrels for settling and fermentation ranging between 2-3 days for quality oil. Oil suspended is skimmed off and refined immediately to avoid rancidity. Refining involves boiling the oil to evaporate water. Oil is cooled, filtered and stored in lightproof, airtight containers in a cool place. Containers for re-use are not cleared of previous oil, affecting oil quality. Challenges processors face include lack of improved coconut oil extraction technologies, financial constraints, lack of support from local authority. The small- scale coconut oil extraction provides job for the youth therefore the need to promote the industry by provision of modern and improved technologies, credit and training.
Keywords: Small-scale processors, Operations, Constraints, Wet processing, Rotary Grater.

1. Introduction

Coconut is considered a very important economic crop in the coastal regions of Ghana, especially in the rural communities providing employment particularly to the youth and womenfolk. The estimated production volume is 320,000 metric tonnes output in 2007 (MOFA, 2010). Coconut is a famous oil seed throughout the world and the oil may be obtained directly from the fresh kernel (wet processing) or, more commonly, from the copra (NRI, 1995) either by natural fermentation or mechanical process. The fermentation process involves splitting the nut, grating the meat to fine particles, squeezing the milk either manually or mechanically with or without addition of water and allowing the milk to ferment for 36–48 hours (Kamariah et al., 2008). As the major source of lauric oil, its conventional processing technologies are highly developed, involving modern equipment on large-scale production levels.

However, in many developing countries where coconut oil is largely produced, the majority of the produce is still processed using indigenous, aqueous extraction processes (Salunkhe and Desai, 1986). Aqueous coconut processes, because of their suitability for cottage industries (UNIFEM, 1987), have persisted over the years in these countries. New techniques for small-scale processing have also emerged. For example, the small-scale processing of copra was demonstrated to be technically feasible and potentially profitable in the Cook Islands (Barrett *et al*., 1987).

Similarly, the technology for the production of coconut oil through expellers is well developed and many medium scale industries in India produce coconut oil by this method. This work aimed at investigating the various operations involved in coconut oil processing by small-scale processors in the Jomoro district in the Western Region of Ghana as well as identifying the associated constraints.

2. Materials and Methods

2.1. Study Area

The Jomoro district lies between latitudes 04º 55'-05º 15' N and longitudes 02º 15'-02º 45' W and is bordered on the north by Wassa Amenfi and Aowin Suaman districts, Nzema East district on the East, La CÔte d'Ivoire to the West and the Gulf of Guinea to the south. The size of the district is 1344 sq. km. The district lies in the tropical rainforest belt with the coastal vegetation being largely mangrove swamp. The climate is classified as equatorial monsoon with small fluctuations in mean annual temperature, air pressure and humidity. The district is hot and humid. August is the coldest month and March is the hottest. The relative humidity reaches 90% at night and drops to 75% in the afternoon. The driest period is December and January. The district experiences two rainy seasons from April to July and September to November. There is a short dry spell in August and longer dry period in December to January. Although February and March are relatively hot, a number of rains usually allow cropping to begin. The district is the wettest part of the country with average annual rainfall of more than 1732mm (Jomoro District Assembly, 2004). The climatic conditions in the area makes it favourable for extensive coconut production.

2.2. Questionnaire Design and Administration

A questionnaire was designed using a mixture of open and close questions, covering demographic; pre-treatment of raw materials; oil extraction process and equipment; post extraction operation; product quality, packaging and storage conditions; financial support, challenges and constraints and by-product utilization. Modified questionnaires after pre-testing were administered to respondents in randomly selected processing centres. Thirty (30) processors were randomly selected from the following four processing centres/villages namely Kabenla-Suazo, Ezinlibo, Nawuley and Nuba for the study.

2.3. Statistical Analysis

Statistical analysis was carried out on the data obtained using Statistical Package for Social Scientists (SPSS) version 20 and results presented in the form of graphs, tables, figures and pictures.

3. Results and Discussion

3.1. Demographic Characteristics

The demographic characteristics indicates that females represent 47% while males represent 53%. The high percentage of males shows that men are more involved in oil extraction business in the centres since the work itself is tedious. This has been indicated by Bailey and Peoples (2013), that difference in strength due to biological difference allow men to perform tasks requiring great strength more efficiently. A total of 87% of the interviewee were between 20-49 years. Majority (60%) were between the ages 20-39 years with 27% between 40-49years (Table 1).

The high percentage recorded as youth buttresses the strenuous nature of the work requiring the energetic youth apart from being main source of their livelihood. On marital status 60% are married while 40% are single. This shows that majority have greater responsibilities and are dependent on the oil extraction business to cater for their family. An average literacy rate of 53.3% but low level of education was observed among respondents with 20% JHS, 20% MSLC, 10% secondary 3.3% primary education while 46.7% are illiterate (Table 1). The literacy rate obtained in the study shows a little improvement over the 50.9% of literacy obtained in the 2000 PHC conducted by the Ghana Statistical Service in the district (GSS, 2005).

Table 1: Distribution of demographic information of the respondents

Variable	Response	No. of respondents	Total (%)
Gender	Male	16	53
	Female	14	47
Age range	<20	1	3
	20-29	9	30
	30-39	9	30
	40-49	8	27
	50-59	3	10
	≥60	0	0
Marital status	Single	12	40
	Married	18	60
Education level	Non-formal	14	46.7
	Primary	1	3.3
	JHS	6	20
	MSLC	6	20
	SHS	3	10

3.2. Equipment and Materials used in Coconut Oil Extraction in the Processing Centres

The extraction processes involve the use of some equipment and materials which are locally manufactured. (Table 2).

Table 2. Equipment/ materials and their uses in coconut oil extraction by the processors

Equipment/material	Use
Knife/wooden pole	Harvesting mature coconuts
Metal Spike	For dehusking the dry coconut
Cutlass	For breaking and removing the meat from the shell
Rotary Grater	For size reduction/Crushing of meat
Baskets	Sieving to obtain the milk from the fibre
Flat iron cooking pan	For drying(boiling) of oil on fire
Barrels (plastics/metals)	Storage during the fermentation/settling process and after drying and filtration
Stirring rod (wooden)	For stirring the oil during the drying process

3.3. Coconut Oil Extraction Operations and Procedures

Harvesting of the mature nuts is carried out by allowing them to fall naturally, by climbing the trees and picking, or by cutting the nuts using a knife attached to a long pole. Immature nuts are not harvested as they contain less oil. Harvested nuts are de-husked by means of a wooden or metal spike fixed into the ground. The coconut is brought down forcibly on to the spike by the operator and twisted to remove portions of the husk. The process is repeated until the entire husk is removed. The nuts are then cracked and the meat removed from the shell using a cutlass. The meat (Figure 2A) is poured into the hopper of the rotary grater. Pressure is applied on the meat in the hopper using a stick as the machine rotates to facilitate easy flow of the meat through the hopper to be crushed. The crushed meat (fibre) is then collected (Figure 2C) into a basket and mounted on a metal/plastic container which have been overlaid with some sticks to support the basket. This is often carried out on a river side for easy access to source of water. Water is added and mixed using the hand to obtain the milk which drains through the basket into the metal/plastic container (Figure 2D). The milk obtained after the fibre is exhausted is then decanted into long plastic/metal barrels for the settling/fermentation period which ranges from 2-3 days for quality oil (Figure 2E). Kamariah et al., (2008), indicated that the fermentation process involves squeezing the milk either manually or mechanically with or without addition of water and allowing the milk to ferment for 36–48 hours. Prolonged settling/fermentation period (4-5 days) may yield more but rancid oil. The oil suspended on the water surface is skimmed off into another container for refining which involves drying/boiling and filtration (Figure 2F).

In the dry season, salt/sea water is added to the milk, which the processors claim helps melt the oil since it becomes viscous during such season. Oil is also extracted from the discarded fibre. This is normally done by women who collect the fibre and re-grind. Afterwards, the extraction follows the same procedure as stated above. According to the processors, this second extraction process was not done previously but trials produced appreciable oil quantities and based on this experience, they were prompted to undertake such an activity. The double extraction processes ensure that maximum oil is obtained from the fibre and so enhance efficiency of oil extraction. The next stage is drying of the oil by boiling (Figure 2G).

The main objective of drying is to evaporate the water in the oil. This is done in a flat iron cooking pan on fire (coconut husk as fuel) with occasional stirring using a long wooden rod. The drying process takes between 2-3 hours to ensure proper drying. After drying and cooling filtration is done by suspending a perforated metal pan on either a metal or plastic container supported by sticks with or without jute sack/fine sieve as the filtering material in the pan (Figure 2H) for the oil to drain. The refined oil is stored in large lightproof, airtight and moisture proof containers in a cool dry place around 24°C (Figure 2I). Below is the flow chart of the wet processing coconut oil extraction method employed by the processors (Figure 1).

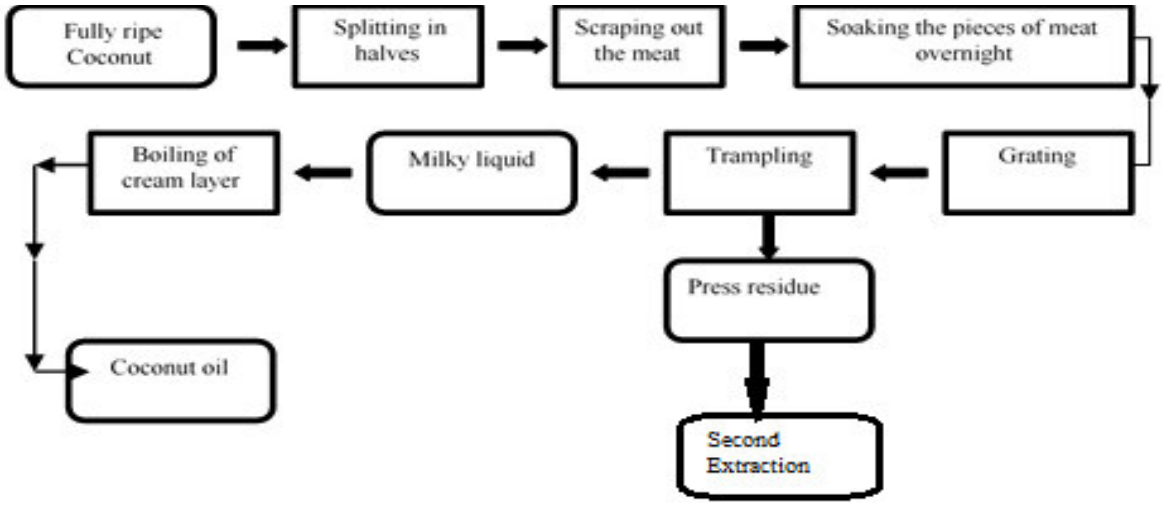

Figure 1: Flow chart of the wet method of coconut oil processing employed by the processors

Figure 2: Plates showing the various processing operations;
2A; Coconut meat removed from the shell for crushing,2B; Rotary Grater used for crushing the meat 2C; crushing of the meat, 2D; mixing crushed meat with water to obtain milk, 2E; settling/fermentation process 2F; skimming suspended oil from water surface after settling, 2G; drying/boiling process, 2H; filtering cooled oil after drying, 2I; storage of coconut oil in large plastic containers

3.4. Packaging and Storage Conditions of Coconut Oil after Extraction

Both metal and mostly plastic containers ranging from 10 to 100 litres or more are used for oil storage (Figure 2I). These containers are light, air and moisture proof which enhances the shelf life of the oil. This was confirmed by Fellow et al., (1995), that the main factors that cause rancidity in addition to moisture, bacteria and enzymes are light, heat and air. Therefore, to achieve a longer shelf life, oils should be stored in moisture proof, lightproof and airtight containers in a cool dry place. The oil is also stored under temperature of 24°C since high temperatures can affect the quality. This was also confirmed by Loncin and Jacobsberg (1965), that the rate of oxidation increases with elevated temperatures.

As temperature is increased, change in oxygen partial pressure influences oxidation rate because oxygen becomes less soluble in water. However, the containers used previously are neither washed nor sterilized before re-used. This may affect the quality of the next oil since the environmentally exposed traces of the previous oil might have undergone rancidity. Fellow et al., (1995) reported that great care is needed to remove all traces of oil from re-usable containers, and thorough drying necessary before refilling because any residual moisture or rancid oil will rapidly deteriorate the quality of fresh oil.

3.5. Challenges facing the Industry

Some of the challenges facing the small-scale coconut oil processors in all the centres under study include the following:

1. Lack of credit facilities to purchase equipment and raw materials.
2. Lack of ready market due to lack of interest as a result of bad perception of coconut oil as high in saturated oil, which has unfavourable health implications.
3. Lack of government policies on coconuts and inadequate support.
4. Transportation problems due to inaccessible roads to transport the raw materials to the extraction centres.
5. Lack of innovative skills and technical know-how to improve the industry and export the oil produced.
6. High cost of acquisition of machines.
7. Neglect of the industry by the District Assembly (Authority)
8. Loans given by women groups attract higher interest which reduces their profit margin.
9. Upper respiratory problems. For example, serious coughing due to smoke inhalation during the drying process.

Figure 3 is a graphical illustration of the sources of financial support for the small-scale processors indicating that most (80%) of them self-finance their business while 13% and 7% are supported by women's association and the Jomoro rural bank respectively.

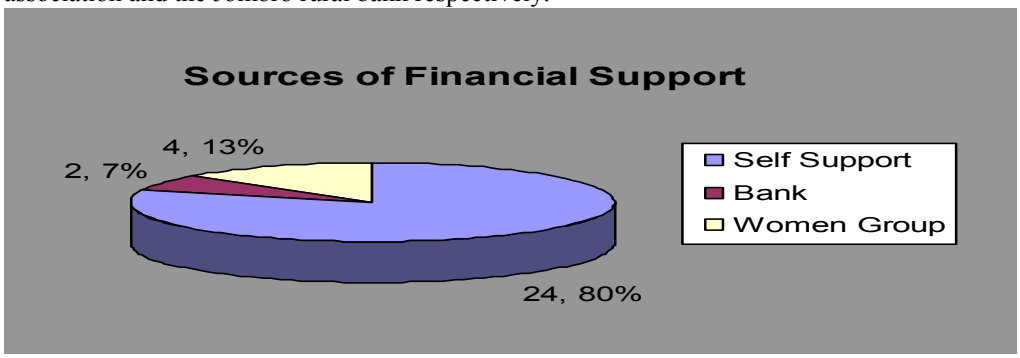

Figure 3: Graphical illustration of the centres sources of financial support.

3.6. By-Products and Utilization

The by-products of the oil extraction process include the husk, shells, cake and the fibre. The interview also revealed that the by-products are efficiently used as follows:

1. Husk-It is used as fuel for the drying process, also as fuel by bakers and fishmongers.
2. Shells-It is sold Wienco a mosquito coil and gun powder manufacturing company situated in the area.
3. Cake/Fibre-Used for feeding animals especially poultry and pigs.
4. Left over milk-The left over milk after skimming off the oil is used as disinfectant to bath pigs.

4. Conclusion

The study revealed that the only extraction method employed is the wet processing method using the rotary grater for size reduction. To obtain good quality oil the best settling period should range from 2-3 days. However, prolonged settling period (4-5 days) may yield more but rancid oil. Most of the processors refine the oil immediately after skimming with drying and filtration being the only refining processes employed. The oils

produced are normally stored in lightproof, airtight and moisture proof containers and containers are neither sterilized nor washed before re-used. This may affect the quality of the subsequent batch traces of the previous oil might have undergone rancidity. The by-products are efficiently utilized as fuel locally and as animal feedstuff. The industry faces a number of challenges among which are financial constraints lack of improved coconut oil extraction technologies, inadequate ready-market, bad roads and lack of support from the local authority. The industry provides job for a large number of the youth in the area, therefore, the local authority and other interest groups should assist in acquisition of modern and improved technologies, credit and training to enhance the operations of the small-scale coconut oil extraction industry in the area.

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